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Abundance and Composition of the Northern Pike Population in Minto Lakes, 1997

by
Stafford M. Roach

July 1998

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

*FISHERY DATA SERIES NO. 98-**

ABUNDANCE AND COMPOSITION OF THE NORTHERN PIKE POPULATION IN MINTO LAKES, 1997

by

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ABSTRACT

Abundance and composition of the northern pike *Esox lucius* population found within the Minto Lakes Study Area in late June 1997 was described using mark-recapture techniques. Estimated abundance of northern pike ≥ 400 mm FL was 16,546 fish (SE = 1,754; CV = 11%). The 95% profile-likelihood bounds were 13,680 and 20,876 fish ≥ 400 mm FL (90% were 14,111 and 20,143). In comparison to five previous estimates of abundance for Minto Lakes northern pike ≥ 525 mm FL from 1987 to 1991, which ranged from 11,257 (SE = 3,075) to 27,418 (SE = 6,800) northern pike, abundance of Minto Lakes northern pike ≥ 525 mm FL in 1997 was 14,639 (SE = 1,552). Fork lengths measured from 2,289 northern pike ≥ 400 mm FL ranged from 400 mm to 1,089 mm. The estimated proportion of fish ≥ 400 mm FL that were also ≥ 725 mm FL was 0.04 (SE < 0.01). Ages determined from the scales of 2,212 northern pike ≥ 400 mm FL ranged from age-3 to age-16 and of these, 54% (SE = 1%) were age-5. The mean error in assigning the proper incremental ages from the scales of 63 northern pike recaptured from previous years was - 0.92 years ($Z = 4.73$; $P < 0.01$). The estimated average percent error of the scale reader in observing the same age twice from a Minto Lakes northern pike scale in 1997 was 2.3%.

Key Words: Northern pike, *Esox lucius*, population abundance, age composition, length composition, Minto Flats, Minto Lakes, mark-recapture.

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) initiated northern pike *Esox lucius* studies in the Arctic-Yukon-Kuskokwim Region of Alaska (AYK) to insure that annual harvests do not exceed surplus production of northern pike. Objectives designed to meet this goal have included estimates of abundance, length composition, age composition, mortality rates, recruitment, and movements of northern pike within selected lakes and wetland complexes in AYK. Prior to 1996, ADF&G conducted mark-recapture experiments in Minto Flats from 1987 through 1991 (Burkholder 1989, 1990, 1991; Hansen and Burkholder 1992). Generally, these sampling events were conducted during spring or fall movements of northern pike and were concentrated in the Minto Lakes area of Minto Flats. The designs of these between-season and between-year mark-recapture experiments were contingent upon either, 1) marked fish being distributed throughout Minto Flats during the recapture event to estimate abundance of northern pike for the entire Minto Flats; or, 2) the fidelity of northern pike to the area of Minto Lakes from one season to the next or one year to the next to estimate abundance for a subpopulation of northern pike. These studies were abandoned after 1991 because investigations indicated that these assumptions were not valid for between-year or between-season experiments. It was hypothesized that a within-season estimate of abundance for the Minto Lakes area of Minto Flats may be more practical and less susceptible to bias from site infidelity.

A Minto Lakes northern pike radiotelemetry study from 1995 to 1996 suggested the feasibility of using a single-season mark-recapture experiment to estimate abundance and composition (Roach 1998). Using information gained from that study, a Minto Lakes northern pike mark-recapture experiment was conducted in 1996 (Roach 1997), which was different than previous years. The hiatus between the marking event and the recapture event was reduced by a magnitude of months to several days, sampling took place in June instead of early May or September, and the study area was uniformly sampled instead of sampling only a limited number of locations. The hiatus was reduced to eliminate the need to adjust estimates of abundance because of growth recruitment between events and reduce the opportunity for fish to leave or enter the study area. Based on the radiotelemetry data, which indicated negligible northern pike movement into and

out of the Minto Lakes area during June compared to the spring and fall, sampling took place in June.

Even though the 1996 mark-recapture experiment was viewed a success in that it resulted in an estimate of abundance, low catch rates were a nagging problem and resulted in a broad confidence interval. Improving upon the 1996 experiment, the 1997 experiment was designed to increase catch rates by lengthening the experiment, adding hoop traps as an additional capture method, and sampling during the cooler hours of the day to enable the use of more gear and longer soaks.

1997 RESEARCH OBJECTIVES

Stock status of Minto Lakes northern pike was evaluated using a two-event mark-recapture experiment in 1997. The research objectives were to:

1) estimate the population abundance of northern pike ≥ 400 mm FL in Minto Lakes such that the estimate is within 25% of the actual value 90% of the time; and,

2) estimate the age and length compositions of the northern pike population ≥ 400 mm FL in Minto Lakes such that the estimates of proportions are within 5 percentage points of the actual value 95% of the time.

DESCRIPTION OF MINTO FLATS STUDY AREA

Minto Flats is located approximately 50 km west of Fairbanks, Alaska within the Tanana River drainage (Figure 1). It is a 200,000 ha area of marsh and lakes interconnected by numerous sloughs and five rivers: the Chatanika, Goldstream, Tatalina, Tolovana, and Tanana (Figure 2). Except for the Tanana River, these rivers are slow flowing and meandering. The Tanana River is a large glacial river that delineates the southern border of the flats and is the primary water source for Swanneck and Grassy Sloughs. The lakes of Minto Flats are generally shallow and contain large areas of dense aquatic vegetation. Summer habitat for northern pike in Minto Flats covers approximately 6,000 ha (Holmes and Pearse 1987). Investigators, however, identified the Minto Lakes area[1] of Minto Flats as a primary northern pike spawning and summer feeding area. In recent years, the majority of Minto Flats northern pike sport fishing effort has occurred in the Minto Lakes area. ADF&G concentrated on this area for mark-recapture experiments (Burkholder 1989, 1990, 1991; Hansen and Burkholder 1992; Roach 1997). In addition to northern pike, least cisco *Coregonus sardinella*, humpback whitefish *C. pidschian*, broad whitefish *C. nasus*, sheefish *Stenodus leucichthys*, Arctic grayling *Thymallus arcticus*, burbot *Lota lota*, longnose suckers *Catostomus catostomus*, blackfish *Dallia pectoralis*, slimy sculpin *Cottus cognatus*, and lake chub *Couesinus plumbeus* are found in Minto Flats. Chinook salmon

[1] This area is also referred to in some reports as Minto Flats Area I, which includes the lakes, channels, and sloughs that empty into the Chatanika River by way of Goldstream Creek (see Figure 2).

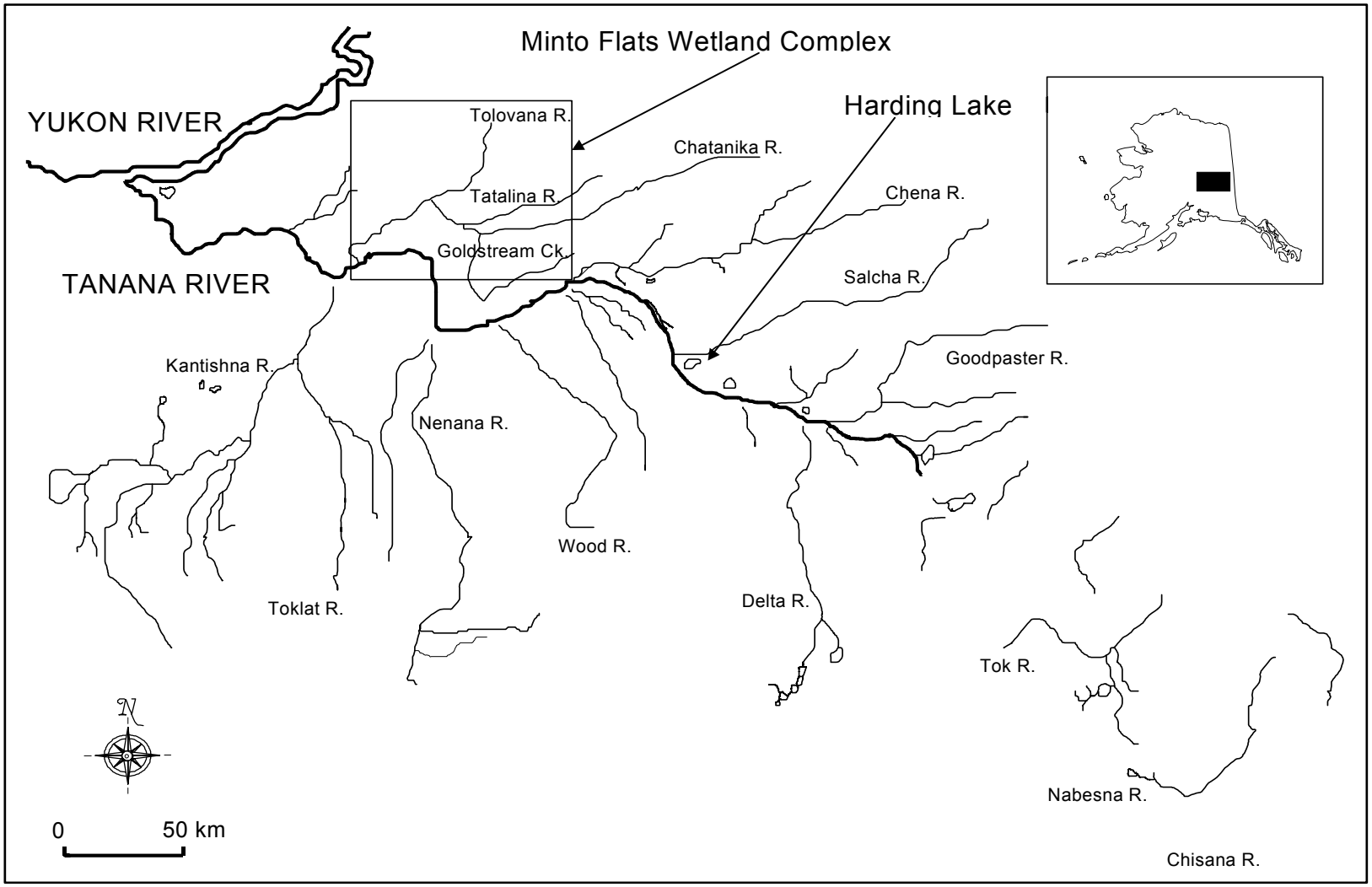

Figure 1.–Tanana River drainage.

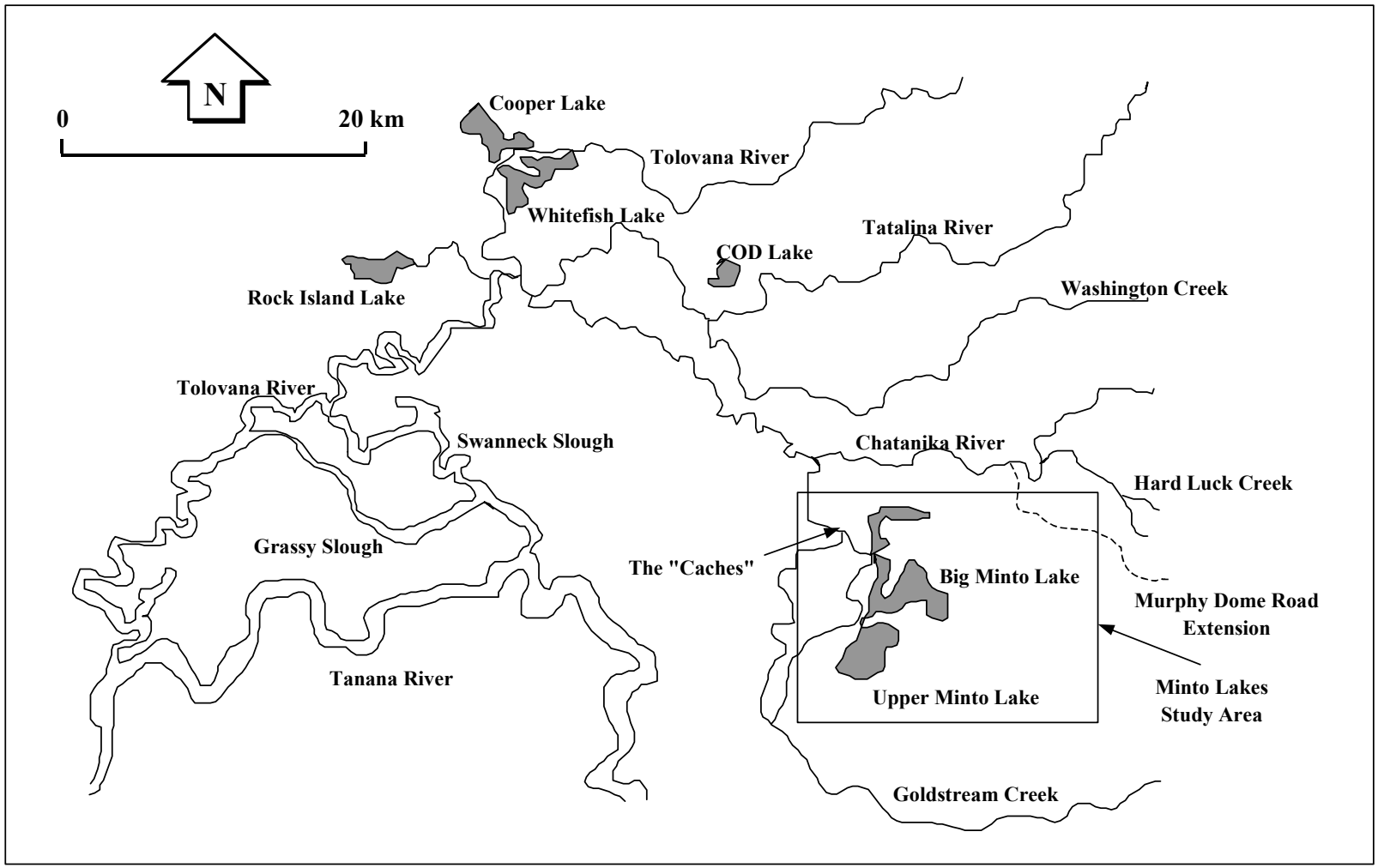

Figure 2.–Minto Flats wetland complex.

DESCRIPTION OF MINTO FLATS NORTHERN PIKE FISHERY

Minto Flats supported the largest sport fishery for northern pike in Alaska in 16 of the last 20 years (Mills 1979 - 1994; Howe et al. 1995 - 1997). From 1981-1984, the average sport harvest in Minto Flats was 2,279 northern pike. In 1985, however, a new sport fishery developed on a concentration of over-wintering northern pike in the Chatanika River. This fishery resulted in an increase in the estimated sport harvest from 2,349 northern pike in 1984 to 4,665 fish in 1985, and 4,903 in 1986. Angler reports and limited creel survey sampling (Holmes and Burkholder 1988) indicated that a large proportion of the harvest from this new fishery was prespawning females.

Due to the increased winter harvest of large female northern pike, which concentrate in few locations and are easily caught, ADF&G closed the Minto Flats winter sport fishery for northern pike by emergency order in January 1987. In the spring of 1988 the Alaska Board of Fisheries restricted the sport-fishing season to June 1 through October 14 and reduced the bag limit to five northern pike a day, only one of which can be over 30 inches TL (≈ 725 mm FL). Since the current regulations have been in effect, the estimated sport-fish harvest of northern pike in Minto Flats has fluctuated from 872 in 1989 to 8,438 in 1994 (Mills 1988 - 1994; Howe et al. 1995 - 1997; Table 1). In addition, estimated angler days fluctuated from 699 in 1989 to 6,267 in 1994. This fluctuation in effort and harvest emphasizes the need for the capability of assessing the Minto Flats northern pike population.

A subsistence fishery for northern pike occurs near the present village site (New Minto) and at historically used sites in the eastern portions of Minto Flats (Andrews 1988). Gill nets are used to catch northern pike throughout the open-water period and hook-and-line techniques are primarily used to capture fish through the ice. During the years 1983 - 1988, estimated subsistence harvest ranged from a high of 3,003 northern pike in 1983 to 10 northern pike in 1986 (Russ Holder, ADF&G, memorandum dated January 13, 1989). The estimated 1994-subsistence harvest was 2,997 northern pike (Jim Marcotte, ADF&G memorandum dated February 9, 1995).

In December 1997, the Alaska Board of Fisheries adopted restrictions to ensure that the Minto Flats subsistence and sport-fishing harvest remain sustainable. Given the potential for the over harvest of overwintering northern pike, the board restricted subsistence and sport-fish anglers to the use of single hook within the Chatanika River overwintering area between the mouth of Goldstream Creek and the Murphy Dome Road Extension. The board also put in place measures to restrict all of the Minto Flats northern pike sport fishery to a daily bag and possession limit of one northern pike once the reported winter harvest from the Chatanika River overwintering area reaches 750 northern pike. Furthermore, the Chatanika overwintering area will be closed to subsistence fishing once the reported winter harvest from this area reaches 1,500 northern pike.

METHODS

The 1997 mark-recapture experiment was designed to estimate abundance and composition of the Minto Lakes summer population of northern pike. This experiment was germane to the area

Table 1.–Estimated angler days expended; number of northern pike harvested and caught; and catch per angler day and harvest per catch in Minto Flats, 1977-1996 summarized by all northern pike and northern pike > 725 mm FL[a].

		Number Harvested		Number Caught		Catch/Angler Day		Harvest/Catch	
Year	Angler Days	All	> 725 mm	All	> 725 mm	All	> 725 mm	All	> 725 mm
1977	3,886	3,615	-	-	-	-	-	-	-
1978	3,640	3,300	-	-	-	-	-	-	-
1979	2,709	3,209	-	-	-	-	-	-	-
1980	2,727	3,909	-	-	-	-	-	-	-
1981	2,045	2,009	-	-	-	-	-	-	-
1982	1,791	1,886	-	-	-	-	-	-	-
1983	1,281	1,825	-	-	-	-	-	-	-
1984	1,829	1,960	-	-	-	-	-	-	-
1985	2,011	3,902	-	-	-	-	-	-	-
1986	3,318	3,621	-	-	-	-	-	-	-
1987	1,539	1,161	-	-	-	-	-	-	-
1988	1,564	1,128	-	-	-	-	-	-	-
1989	699	872	-	-	-	-	-	-	-
1990	932	1,182	-	3,967	-	4.3	-	0.3	-
1991	1,532	1,754	297	4,907	535	3.2	0.3	0.4	0.5
1992	2,401	1,247	131	5,765	808	2.4	0.3	0.2	0.2
1993	3,911	2,076	170	19,536	5,238	5.0	1.3	0.1	0.0
1994	6,267	8,438	1,943	47,248	5,408	7.5	0.9	0.2	0.4
1995	6,260	3,126	594	21,823	2,463	3.5	0.4	0.1	0.2
1996	3,973	2,078	659	12,495	1,408	3.1	0.4	0.2	0.5
Average	2,716	2,615	632	16,534	2,643	4.1	0.6	0.2	0.3

a Daily fishing regulations within Minto Flats are such that only one northern pike over 30 inches TL (≈725 mm FL) may be retained or in possession.

of Minto Flats that attracts the majority of sport-fish anglers, and during a time when the population is vulnerable to harvest.

SAMPLING TECHNIQUES

A systematic method was used to sample northern pike in Minto Lakes. The marking event was carried out from June 11 through June 19 and the recapture event from June 25 through July 2. The study area was composed of seven sections (1, 2, 3, 4, 13, 23, 33) which were subdivided into 16 subsections to examine movement, test for differences in catchability, and help insure uniform sampling effort (Figure 3). Generally, sampling took place between midnight and 0800 hours each day. There were two passes through each subsection for each the marking and recapture events. Each of four crews of two individuals systematically sampled one subsection per day such that sampling was not concentrated in a small portion of the area but evenly distributed. Each crew fished two to four hoop traps moving them at the beginning and end of each workday. When not working the hoop traps each crew typically fished two to three gill nets but never more gill nets than would allow fish to be sampled and all gill nets checked within one hour. Each area was sampled evenly and as uniformly as possible by moving the gill nets to new sites within the area throughout the workday. All healthy northern pike were released immediately after data collection, 50 to 100 m from the capture site.

All data from captured northern pike were recorded on ADF&G Tagging Length Mark-Sense Form, Version 1.0. A new form was used for each area. During the marking event, captured northern pike were measured and all ≥ 400 mm FL were sampled. A minimum of two scales were taken from the preferred zone adjacent to but not on the lateral line above the pelvic fins as described by Williams (1955) and mounted on gummed scale cards. Corresponding mark-sense litho-code, date, and water body were recorded on the back of all gummed scale cards. Both the left and right side of the dorsal fin were examined for the presence of a Floy tag. If a Floy tag was present, the color and number of the tag recorded; or if not present, a new Floy FD-68 internal anchor tag inserted at the left base of the dorsal fin and the number recorded. The left pectoral fin of all newly tagged fish was slightly clipped as a secondary mark. Northern pike killed during the sampling procedure were not tagged but all other data were recorded and the fate (K) clearly noted in the blank space after the length on the mark-sense form.

During the recapture event, the same procedures were used with the addition that both the left and right pectoral fins were examined closely for recent clips, and the right pectoral fin, instead of the left, was slightly clipped to signify capture during the event. Tag loss (TL) was clearly noted in the blank space after the tag number on the mark-sense form for northern pike without a Floy tag but with a recent tag wound or recent left pectoral fin clip. Recapture (RC) was clearly noted on the mark-sense form for known recaptures from the marking event. Northern pike were not sampled more than once during the recapture event.

Scales were impressed on 20 mil acetate sheets using a Carver press at 241,315 kPa (35,000 psi) heated to 150°C for 150 s from scales collected in the field on gummed cards. Ages were determined from impressions using a Micron 770 microfiche reader (32X) according to criteria established by Williams (1955), and Casselman (1967). Because scale collection was after the time of annulus formation, growth beyond the last annulus was considered plus growth.

All files used for data analysis are listed in Appendix A1.

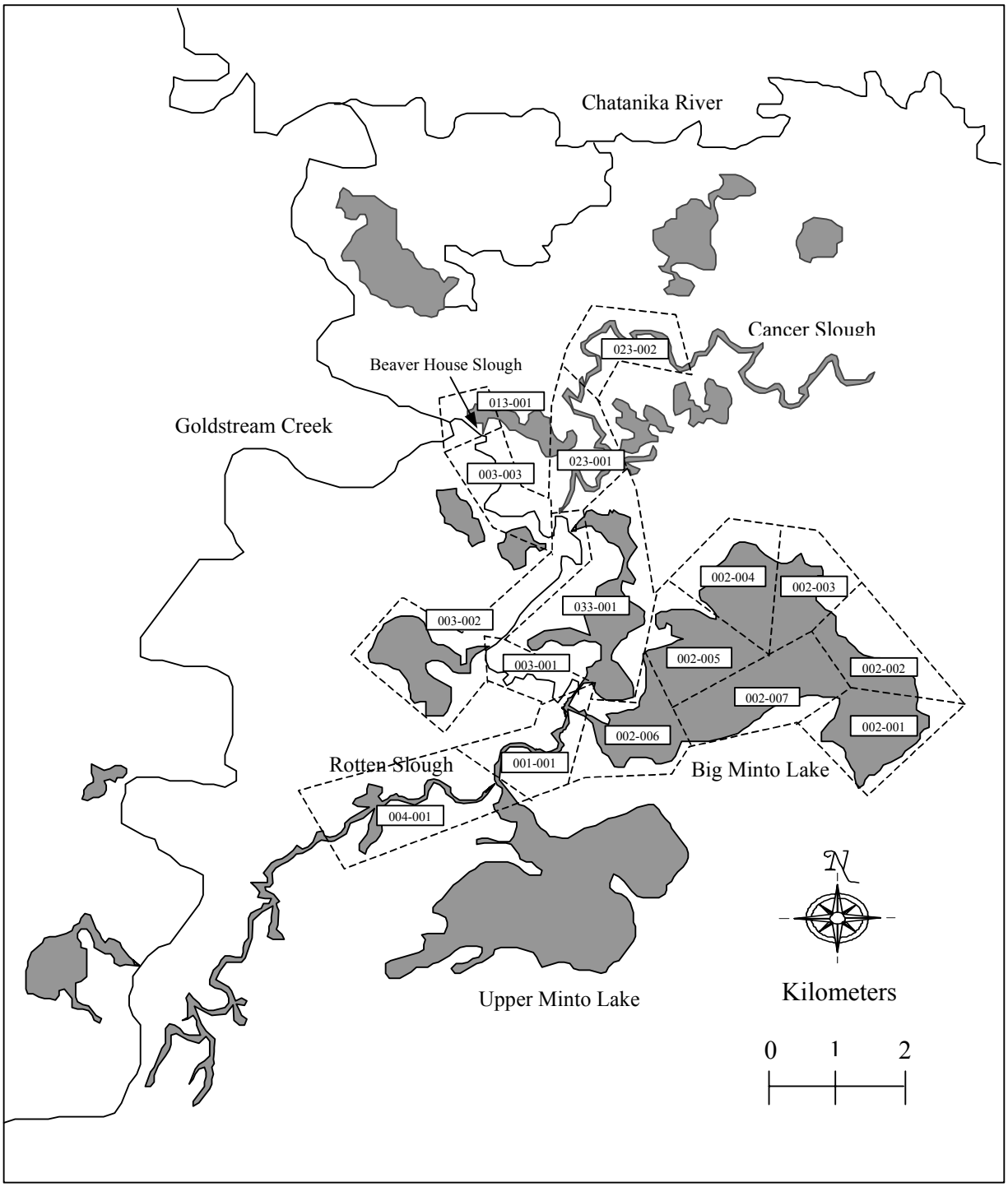

Figure 3.–Minto Lakes study area with designated sampling areas indicated with dashed lines.

ESTIMATION OF ABUNDANCE

Abundance was estimated using a two-sample Petersen mark-recapture experiment (Seber 1982) based on the following assumptions:

1) the population was closed (no change in the number or composition of northern pike during the experiment);
2) all northern pike had the same probability of capture during the marking event or the same probability of capture during the recapture event or marked and unmarked northern pike mixed completely between events;
3) marking northern pike did not affect their subsequent probability of capture;
4) northern pike did not lose their mark between events; and,
5) all marked northern pike were reported when recovered.

The validity of assumption 1 was inferred from information gained from a two-year radiotelemetry study of northern pike movements within the study area and from examination of the movements of marked fish during the experiment. The radiotelemetry study indicated that the least movement of radio-tagged fish occurred between the middle of June and the middle of July. During this time, none of the radio-tagged northern pike left the Minto Lakes Study Area (Roach 1998). Mortality and growth, which may contribute to the violation of assumption 1, were assumed negligible because of the short duration of the experiment (22 days from beginning to end). In the case where assumption 1 is violated by a one way change in numbers (either an increase or a decrease in the number of fish but not both) and the other assumptions are valid, the estimate of abundance is germane to either the marking event or the recapture event but not both. The validity of assumptions 2 and 3 was inferred by the systematic sampling design and from comparing movements of recaptured fish between events. The validity of assumption 2 and 3 was evaluated with tests of consistency designed to detect unequal catchability by area and by size of fish (Seber 1982). The validity of assumption 4 was insured by double marking (Floy tag and fin-clip) each northern pike during the marking event. Tag loss was noted when a fish was recovered during the recapture event with the specific fin clip but without a Floy tag. In addition, Floy tag placement was standardized, which enabled the fish handler to verify tag loss by locating recent tag wounds. The validity of assumption 5 was insured by a thorough examination of fins for fin-clips and the recording of fin clips and Floy tag numbers for all northern pike. Floy tag numbers used for this mark-recapture experiment were archived (Appendix B1).

Estimated abundance of northern pike was calculated from the number of northern pike marked, examined for marks, and recaptured. The Chapman estimator (Seber 1982) was used:

$$\hat{N} = \frac{(M+1)(C+1)}{R+1} - 1 \qquad (1)$$

where: M = the number of northern pike marked and released alive during the marking event;

C = the number of northern pike examined for marks during the recapture event;

R = the number of northern pike recaptured during the recapture event; and,

$\hat{N}$ = estimated abundance of northern pike at the time of marking.

Variance of the abundance estimate (Seber 1982) was estimated as:

$$\hat{V}\left[\hat{N}\right] = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}. \quad (2)$$

ESTIMATION OF LENGTH AND AGE COMPOSITION

Length proportions of northern pike ≥ 400 mm FL were estimated for the Minto Lakes study area. The proportion and variance estimators used were:

$$\hat{p}_k = \frac{x_k}{n}, \text{ and} \quad (3)$$

$$\hat{V}\left[\hat{p}_k\right] = \frac{\hat{p}_k(1-\hat{p}_k)}{n-1} \quad (4)$$

where: $\hat{p}_k$ = the proportion of northern pike that were length *k*;

x_k = the number of northern pike sampled that were length *k*; and,

n = the number of northern pike sampled that were measured.

Age composition was estimated using the same equations for proportions and variances of proportions used to estimate length composition except ages were substituted for lengths. Length and age composition data were archived (Appendices B2, B3).

Accuracy of age-determination from scales of Minto Lakes northern pike captured during the 1996 mark-recapture experiment was tested indirectly. Error in assigning the correct incremental age for each fish was calculated as:

$$\text{ERROR} = AGE_{t+\Delta} - AGE_t - \Delta t \quad (7)$$

where: $AGE_{t+\Delta}$ = age assigned when fish was recaptured;

AGE_t = age assigned at earlier capture; and,

Δt = number of years elapsed from capture to recapture.

Mean error was calculated as the sum of all the errors divided by the number of fish recaptured.

A random subsample of 108 scales was read twice to determine the average percent error (APE of Beamish and Fournier 1981) of the scale reader:

$$APE = \frac{\sum_{i=1}^{S}\left[\frac{\sum_{j=1}^{R}\left|x_{ij}-\bar{x}_i\right|}{\bar{x}_i}}{R}\right]}{S}\cdot 100 \qquad (8)$$

where: x_{ij} = age determined from the j^{th} reading of the i^{th} scale;

$\bar{x}_i$ = average age determined from the i^{th} scale;

R = total number of readings; and,

S = total number of scales in the sample.

APE provides a means to evaluate the reproducibility of ages within a year, but should not be considered independent of age (Laine et al. 1991).

RESULTS

Of the 2,304 unique northern pike handled during the mark-recapture experiment, 884 were tagged and released alive during the marking event of which 75 were subsequently recaptured, and 1,345 new fish were captured during the recapture event (Appendix B4). None were < 400 mm FL. There was no observed tag loss during the experiment, 77 northern pike (3% of fish handled) were inadvertently killed, and 74 northern pike with Floy tags from prior mark-recapture experiments (3% of unique northern pike handled) were identified. During the time of sampling, water temperature varied from 16° to 23° C.

Examination of areas where northern pike were marked with areas where the fish were recaptured indicated movement from the outer margins (sections 1, 4, and 13; Area A) towards the center (sections 2, 3, 23, and 33; Area B) of the study area (Figures 3 and 4). This one-way movement leads to the inference that there may have been movement into the study area but once within the study area all northern pike remained throughout the study. A comparison of the recovery history of fish marked in these two areas indicated significantly different mixing rates between the areas (χ^2 = 15.34; 2 df; P < 0.01; Table 2). This unequal movement resulted in significantly different recapture rates (χ^2 = 11.67; 1 df; P < 0.01; Table 3) between the center (R/C = 0.07) and outer margins (R/C = 0.02) of the study area. Inasmuch as movement into the study area was not ruled out, all fish may or may not have had a similar probability of capture during the marking event. However, a constant proportion of fish marked in each area were recovered (χ^2 = 0.50; 1 df; P = 0.48; Table 4). This suggested that all fish had a similar probability of capture during the recapture event and lends support to the idea that fish marked in the outer margins of the study area did not move out of the study area.

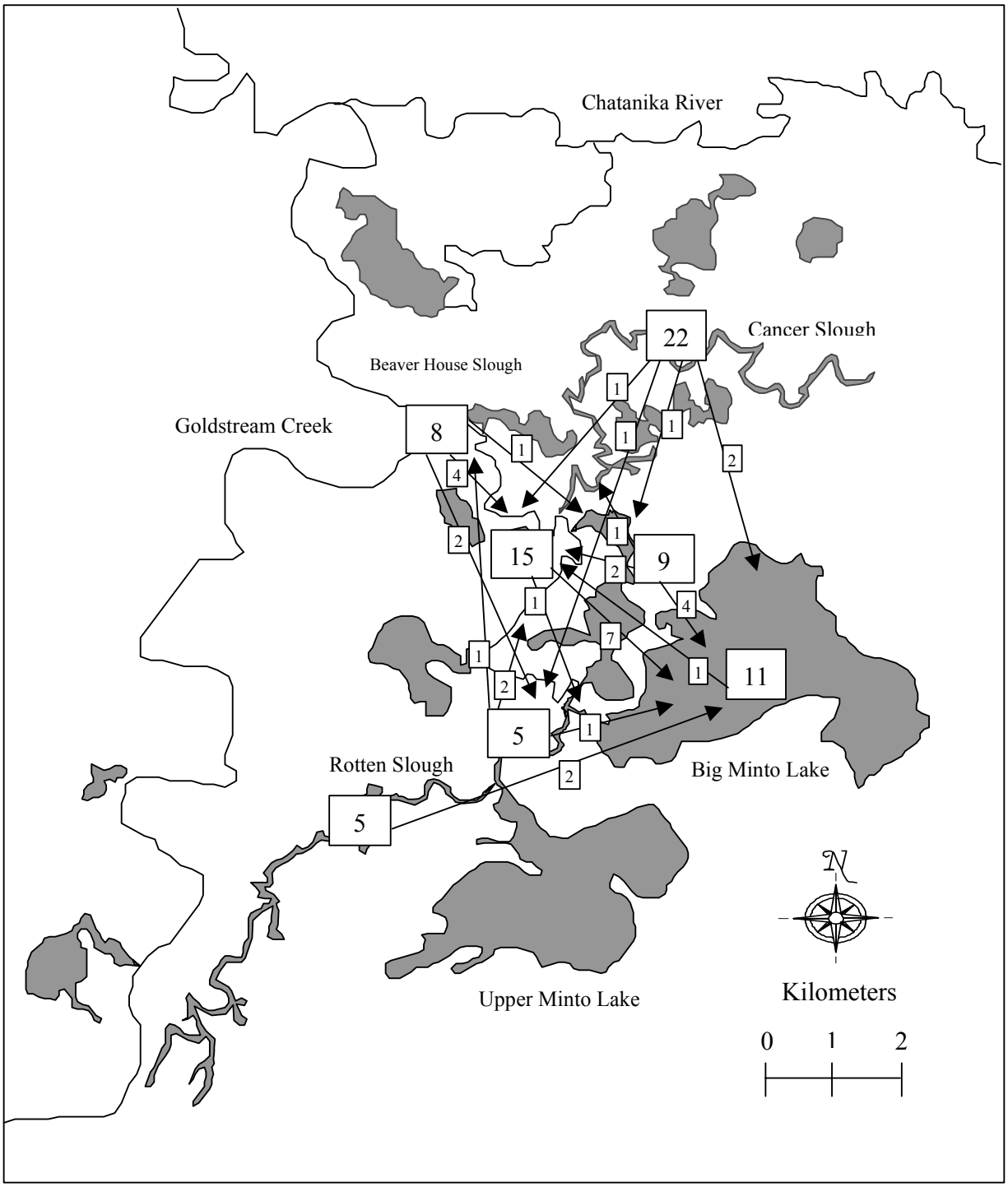

Figure 4.–Minto Lakes study area with number of recaptures indicated by area of marking (large boxes) and the number that moved from the area of marking to another area (small boxes and arrows).

Table 2.-Numbers of northern pike marked in areas A (sections 1, 4, and 13) and B (sections 2, 3, 23, and 33) and recovered in area A, area B, or not recovered.

Marking Area	Recovery History			Total
	A	B	Not Recovered	
A	7	11	225	243
B	2	55	584	584
Total	9	66	809	884

Table 3.-Numbers of marked and unmarked northern pike captured during the recapture event by areas A (sections 1, 4, and 13) and B (sections 2, 3, 23, and 33).

Northern Pike	Capture Area		
	A	B	Total
Marked	9	66	75
Unmarked	410	935	1,345
Total	419	1,001	1,420

Table 4.-Numbers of marked northern pike recovered and not recovered during the recapture event by areas A (sections 1, 4, and 13) and B (sections 2, 3, 23, and 33).

History	Marking Area		
	A	B	Total
Recovered	18	57	75
Not Recovered	225	584	809
Total	243	641	884

Additionally, there were no significant differences between the length distributions of fish marked and fish recaptured ($D = 0.15$; $P = 0.07$; Figure 5) or between the length distributions of fish marked and fish captured during the recapture event ($D = 0.04$; $P = 0.29$; Figure 5). This suggests that there was no length selectivity during either event.

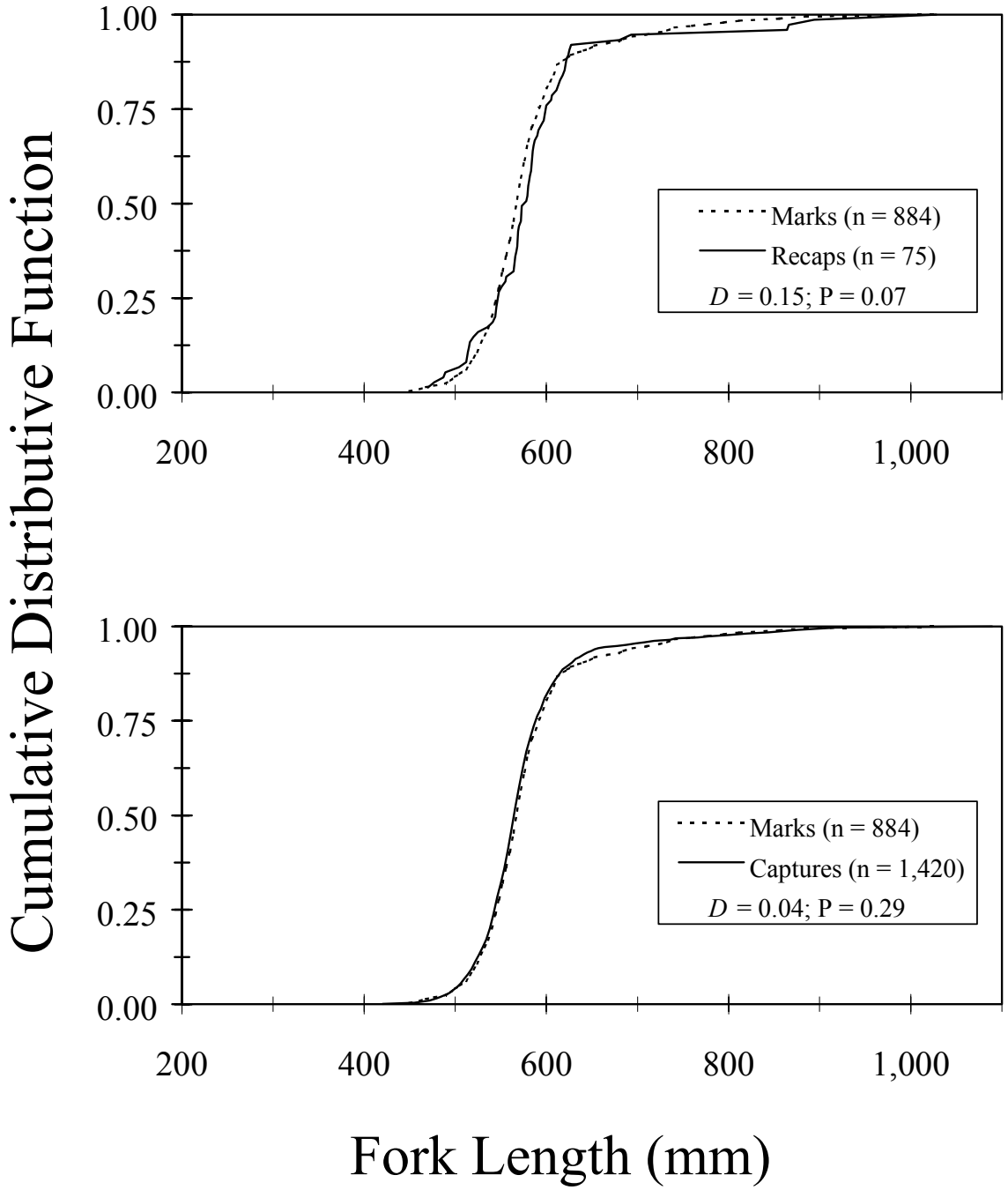

Figure 5.–Cumulative distribution functions of fork lengths of northern pike marked versus recaptured and marked versus captured in Minto Lakes.

Given the condition that there may have been one-way movement into the study area, that sampling during the recapture event was uniform, and that there was no length selectivity during either event, abundance was estimated using the unstratified Chapman estimator based on the hypergeometric probability distribution. Estimated abundance of northern pike within Minto Lakes was germane to fish ≥ 400 mm FL during the time of the recapture event (late June to early July 1997). Estimated abundance of northern pike ≥ 400 mm FL within Minto Lakes was 16,546 fish (SE = 1,754; CV = 11%). The 95% profile-likelihood bounds were 13,680 and 20,876 northern pike ≥ 400 mm FL (90% were 14,111 and 20,143).

Inasmuch as size selectivity was not detected for either the marking or the recapture events, fork lengths from both events were pooled for estimating length composition. Fork lengths measured from 2,289 northern pike ≥ 400 mm FL in Minto Lakes ranged from 400 mm to 1,089 mm. The estimated proportion of fish ≥ 400 mm FL that were also ≥ 725 mm FL was 0.04 (SE < 0.01; Figure 6).

Of the 2,304 unique northern pike (≥ 400 mm FL) sampled during the Minto Lakes mark-recapture experiment, age was not determined for 92 (scales were not taken or lost from 14 fish, not readable because of regeneration from 66 fish, and not readable because of poor acetate impression from 12 fish). Ages determined for each of the remaining 2,212 northern pike—853 from the marking event and 1,359 from the recapture event—ranged from age-3 to age-16. For 63 of these northern pike, age had been determined in a year previous to 1997. The mean error in assigning the proper incremental age from these scales was -0.92 years ($Z = 4.73$; $P < 0.01$); and the estimated average percent error of the scale reader in observing the same age twice from the same scale in 1997 was 2.3% (Figure 7). Of Minto Lakes northern pike ≥ 400 mm FL, an estimated 54% (SE = 1%) were age-5 (Figure 8).

DISCUSSION

With further improvements in methods from 1996, the 1997 population assessment of Minto Lakes northern pike resulted in a much lower coefficient of variation. In addition to using a single-season mark-recapture experiment, sampling in June, and using a uniform sampling design, the number of sampling days were increased from eleven to fifteen, hoop traps were used in addition to gill nets, and sampling took place at night in 1997. This along with the lower water levels resulted in a 150% increase in the number of fish sampled and a more precise estimate of abundance for the Minto Lakes summer population compared to 1996. In comparison to five previous estimates of abundance for Minto Lakes northern pike ≥ 525 mm FL from 1987 to 1996, which ranged from 11,257 (SE = 3,075) to 27,418 (SE = 6,800) northern pike, abundance of Minto Lakes northern pike ≥ 525 mm FL in 1997 was 14,639 (SE = 1,552; Figure 9).

In both 1996 and 1997, there was only a small proportion of older northern pike in the Minto Lakes population even though regulations were designed, in part, to allow older fish to remain in the population (Roach 1997; Figure 8). Current regulations limit the harvest of Minto Lakes northern pike to five fish of which only one can be over 30 inches. In 1996 the oldest northern pike sampled from this population was age-13 and in 1997 age-16. Historically the Minto Lakes area has been described as having few large northern pike (Alt 1968; Hinman *Unpublished*). The oldest northern pike sampled by ADF&G personnel from the Minto Lakes area in 1989 was

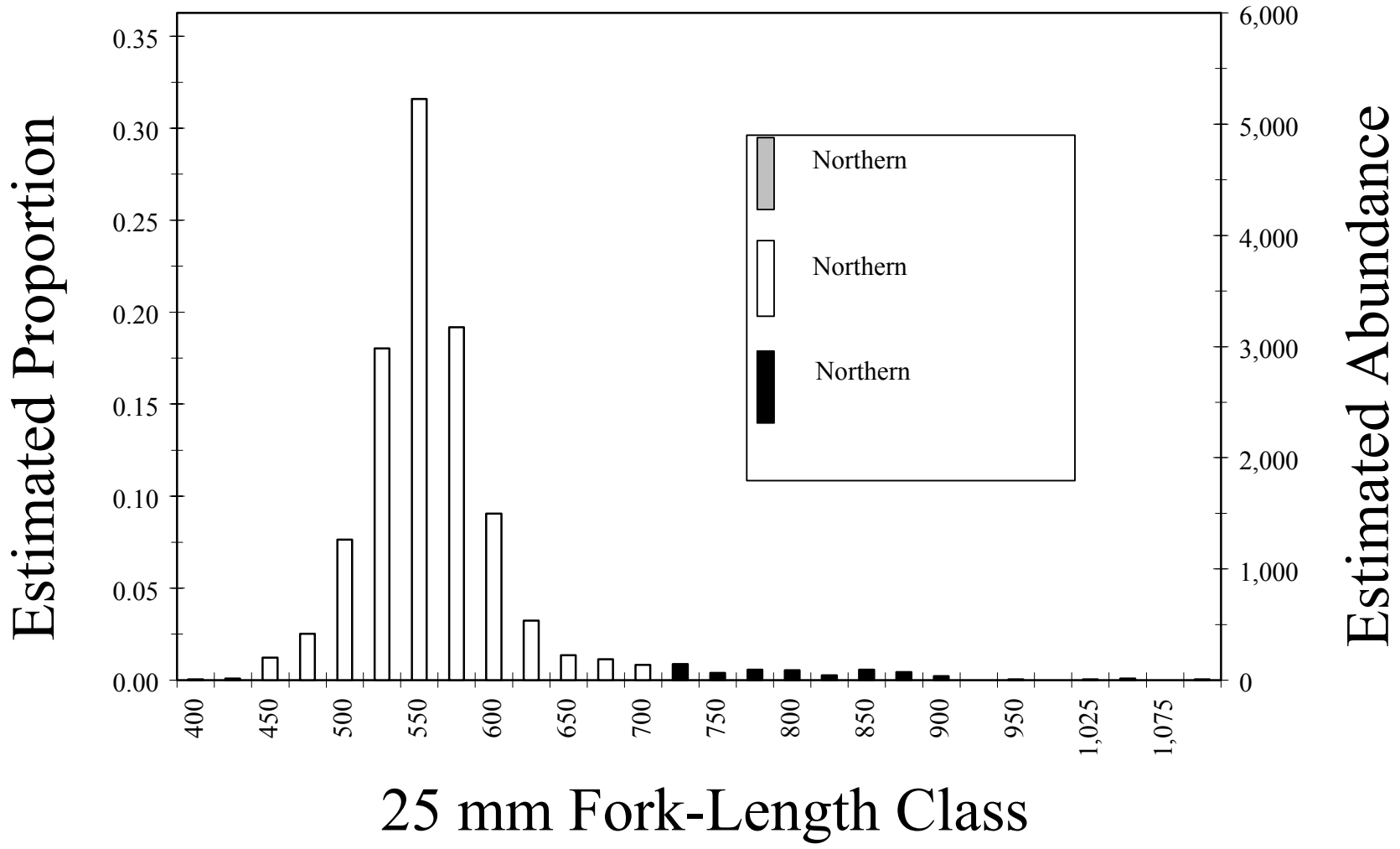

Figure 6.-Estimated proportions and abundances of northern pike ≥ 400 mm FL by 25-mm length classes within Minto Lakes during late June 1997.

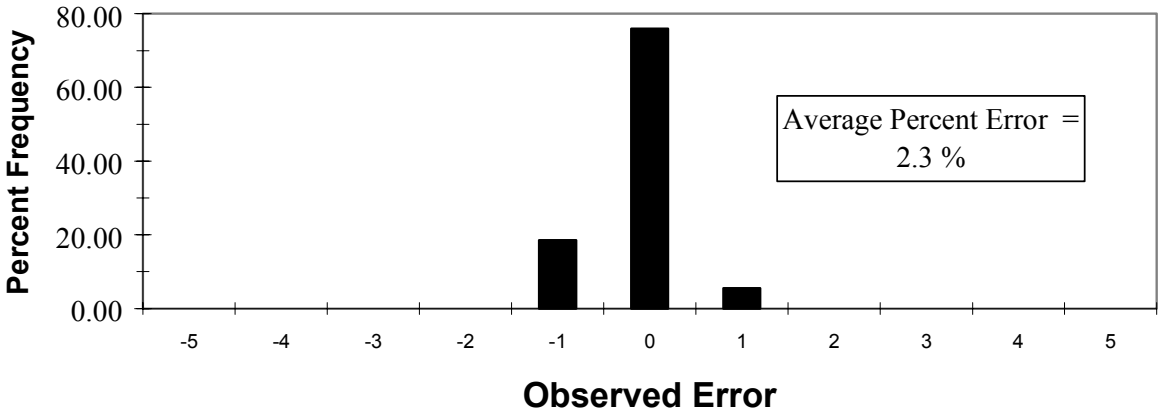

Figure 7.-Percent frequencies for observed errors in observing the same age twice from a Minto Lakes northern pike scale in 1997 (n = 108).

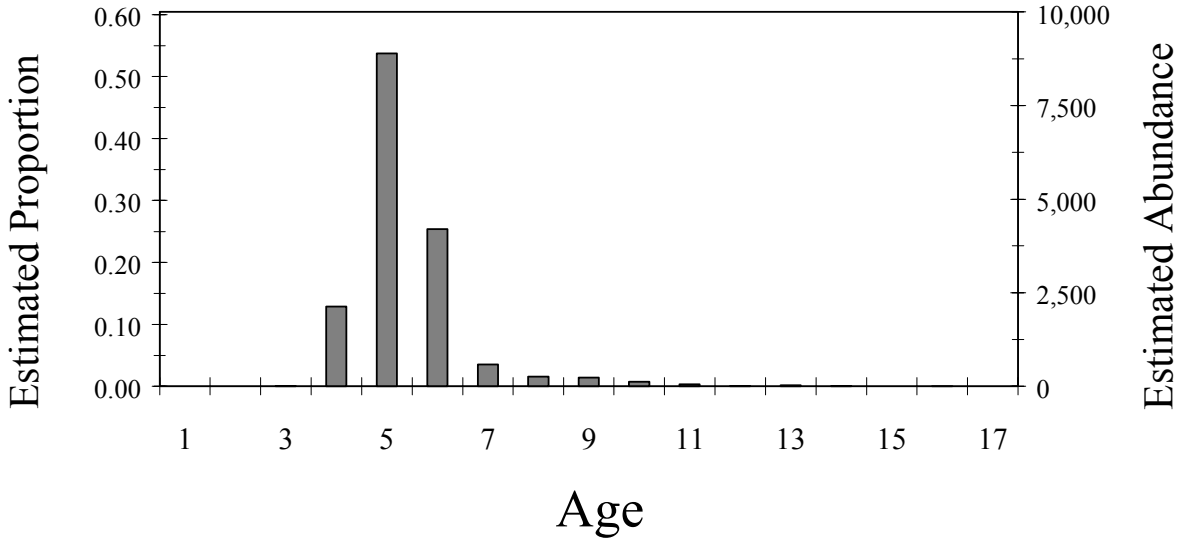

Figure 8.-Estimated proportions and abundances of northern pike ≥ 400 mm FL by ages within Minto Lakes during late June 1997.

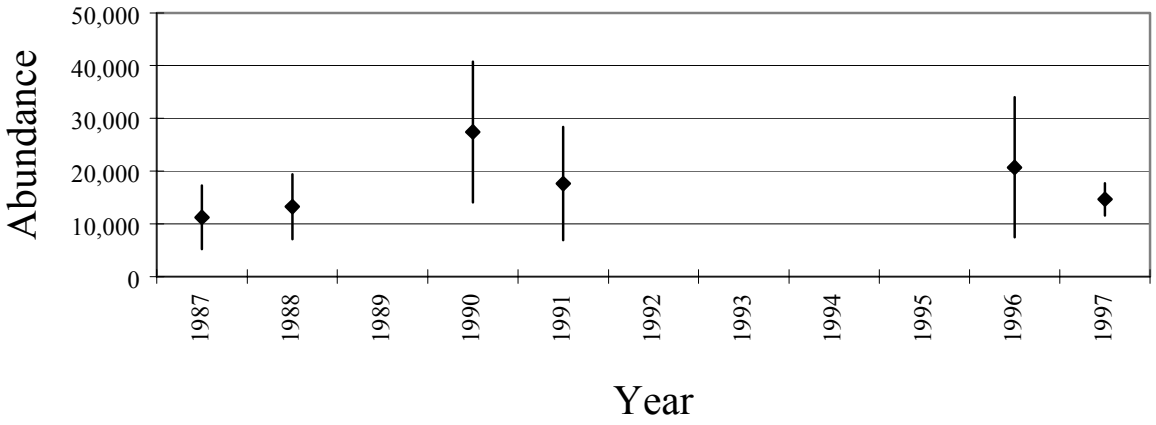

Figure 9.–Estimated abundances and 95% confidence intervals for Minto Lakes northern pike ≥ 525 mm FL by year.

age-9 and in 1995 age-8. The oldest northern pike sampled since 1987 was age-16—one in 1987 and one in 1997 (Burkholder 1989; Burkholder 1990; Burkholder 1991; Hansen and Burkholder 1992; Roach, ADF&G, memorandum dated October 23, 1995; Roach 1997). The consistent lack of older fish indicates that Minto Lakes northern pike suffer high overall mortality rates, which given current regulations and relatively few large fish in the harvest is not explained by angling pressure but probably by high natural mortality. Chatanika River cabin owners have presented anecdotal information that this population has experienced sporadic events of unusually high winter death. A paucity of older fish may be typical of this population due to a high rate of natural mortality.

During the mark-recapture experiment there were no barriers to stop northern pike from moving into or out of the study area. Examination of the movements of marked northern pike during the mark-recapture experiment, however, suggested that movement out of the study area was unlikely, but also indicated that there may have been movement into the study area during the experiment. The unlikelihood of movement out of the study area was supported by the 1995 - 1997 Minto Lakes northern pike radiotelemetry study, which indicated that radio-implanted northern pike did not move out of the study area during the period from the middle of June to the middle of July (Roach 1998). The radiotelemetry study also suggested that movement into the study area peaked prior to spawning and then declined to near zero in a relatively short time after spawning. Whereas the mark-recapture experiment was four to six weeks after the time of spawning, movement into the study area was probably minimal. This evidence along with the diagnostic tests, which indicated that all fish within the study area had a similar probability of capture during the recapture event, suggests that the estimate of abundance was unbiased for the summer population. At worst, however, the estimate of abundance may have been an unbiased snapshot germane to some point during the latter half of the experiment, which, even if so, was probably not much different from the abundance of the summer population.

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APPENDIX A

Data File Listing

Appendix A1.-Data files used to estimate parameters of the Minto Lakes northern pike populations, 1997.

Data file[a]	Description
U014ALAA.DTA	Population and marking data for Minto Lakes northern pike captured during the marking event, June 11 through June 19, 1997.
U014ALBA.DTA	Population and recapture data for Minto Lakes northern pike captured during the recapture event, June 25 through July 2, 1997.

[a] Data files were archived at and are available from the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage, Alaska 99518-1599.

APPENDIX B

Historical Data Summaries

Appendix B1.–Floy tag numbers used for Minto Flats northern pike mark-recapture experiments by year and color, 1987-1997.

Year	Tag Color			
	Green	White	Blue	Gray
1987		27,000-27,999		
		32,500-32,999		
		45,000-45,408		
		58,000-58,220		
1988	89,000-89,045	45,500-45,547		
		49,000-49,822		
		56,000-57,999		
		58,221-58,999		
1989	5,000-5,432			
	7,000-7,344			
1990			60,000-62,764	
			75,000-75,238	
1991			77,000-78,492	
			79,000-79,991	
1992-1993	-	-	-	-
1994				15,000-17,059
				17,450-17,784
1995				9,719-9,735
				53,700-53,749
1996				41,000-41,989
1997				42,000-42,999
				44,000-44,060

Appendix B2.–Sample sizes, estimated abundances, and standard errors by length category for Minto Lakes northern pike, 1996 and 1997.

Fork Length (mm)	1996			1997		
	n	$\hat{N}$	SE	n	$\hat{N}$	SE
400-424	5	133	43	1	7	1
425-449	5	133	43	2	14	2
450-474	12	318	104	28	202	21
475-499	36	955	312	58	419	44
500-524	61	1,618	529	175	1,265	134
525-549	144	3,820	1,249	413	2,985	316
550-574	211	5,598	1,831	723	5,226	554
575-599	138	3,661	1,197	439	3,173	336
600-624	73	1,937	633	207	1,496	159
625-649	35	929	304	74	535	57
650-674	31	822	269	31	224	24
675-699	36	955	312	26	188	20
700-724	22	584	191	19	137	15
725-749	17	451	147	20	145	15
750-774	13	345	113	9	65	7
775-799	7	186	61	13	94	10
800-824	9	239	78	12	87	9
825-849	14	371	121	6	43	5
850-874	15	398	130	13	94	10
875-899	5	133	43	10	72	8
900-924	5	133	43	5	36	4
925-949	-	-	-	-	-	-
950-974	2	53	17	1	7	1
975-999	2	53	17	-	-	-
1,000-1,024	1	27	9	1	7	1
1,025-1,049	-	-	-	2	14	2
1,050-1,074	-	-	-	-	--	-
1,075-1,099	-	-	-	1	7	1
Totals	899	23,850	7.799	2,289	16,546	1,754

Appendix B3.–Sample sizes, estimated abundances, and standard errors by age for Minto Lakes northern pike, 1996 and 1997.

Age	1996			1997		
	n	$\hat{N}$	SE	n	$\hat{N}$	SE
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	5	142	47	2	15	2
4	60	1,708	558	284	2,126	225
5	425	12,096	3,955	1,188	8,894	943
6	214	6,090	1,992	561	4,200	445
7	60	1,708	558	78	584	62
8	28	797	261	35	262	28
9	23	655	214	31	232	25
10	14	398	130	16	120	13
11	6	171	56	7	52	6
12	1	28	9	2	15	2
13	2	57	19	3	22	2
14	-	-	-	2	15	2
15	-	-	-	-	-	-
16	-	-	-	1	7	1
17	-	-	-	-	-	-
18	-	-	-	-	-	-
Totals	838	23,850	7,799	2,210	16,546	1,754

Appendix B4.–Number of northern pike ≥ 400 mm FL marked (M), examined for marks (C), and recaptured with marks (R) by section during Minto Lakes two-event mark-recapture experiments in 1996 and 1997.

Section	1996			1997		
	M	C	R	M	C	R
1	30	38	1	68	184	4
2	165	244	3	214	357	26
3	48	128	1	244	354	21
4	16	27	0	40	179	3
13	39	47	1	135	56	2
23	22	70	1	137	199	13
33	12	18	0	46	91	6
Totals	332	572	7	884	16,546	75